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REPORTS

REDATING FELL'S CAVE, CHILE AND THE CHRONOLOGICAL PLACEMENT OF THE FISHTAIL PROJECTILE POINT

Michael R. Waters, Thomas Amorosi, and Thomas W. Stafford, Jr.

Fell's Cave lies near the Magellan Straits of South America's Southern Cone. This was the first site to provide evidence of a late Pleistocene occupation of South America, and it is the site where the Fishtail projectile point type was defined. Previous radiocarbon ages from Fell's Cave on charcoal samples from three hearths in the late Pleistocene artifact-bearing levels yielded dates ranging from ca. 11,000 to 10,100 radiocarbon years before present. New radiocarbon dates on curated charcoal samples from these same hearths yield revised ages of ca. 10,800 to 10,400 radiocarbon years before present. These new dates from Fell's Cave agree well with ages from other South American sites in the Southern Cone with Fishtail points and show that the Fishtail projectile point was made from ca. 10,850 to 10,300 radiocarbon years before present or ca. 12,800 to 12,100 calibrated years before present.

La Cueva de Fell se encuentra cerca del Estrecho de Magallanes del Cono Sur de Sudamérica. Este fue el primer sitio para proporcionar evidencia de una ocupación Pleistoceno de Sudamérica y es el sitio donde se definió el tipo de punta de proyectil Cola de Pescado. Las edades radiocarbónicas en muestras anteriores de la Cueva de Fell en tres hogares de la época del Pleistoceno tardío arrojaron fechas que van desde ca. 11.000 a 10.100 años de radiocarbono antes del presente. Nuevas fechas radiocarbónicas en muestras de carbón curadas de estos mismos hogares rindieron edades revisadas de ca. 10.800 a 10.400 años de radiocarbono antes del presente. Estas nuevas fechas de la Cueva de Fell concuerdan bien con las fechas de otros sitios Sudamericanos en el Cono Sur con puntas proyectiles Cola de Pescado y muestran que el proyectil Cola de Pescado se hizo durante ca. 10.850 a 10.300 años de radiocarbono antes del presente o ca. 12.800 a 12.100 años calibrados antes del presente.

Fell's Cave, at the southern tip of South America (Figure 1), is an important site in the study of the prehistoric colonization of the Americas by modern humans. Historically, it was the first stratified and dated late Pleistocene-age site in South America to be discovered, excavated, and reported (Jackson 2006; Politis 1991). Here, Junius Bird (1988) initially excavated the site from 1936–1937, defined the Fishtail projectile point type, and suggested that these points, along with other artifacts, were associated with extinct fauna. This discovery came just a decade after the recognition of the Folsom complex and just a few years after the discovery of the Clovis complex in North America. Together, this trio of sites showed that the Americas were occupied during the late Pleistocene. John Fell and French archaeologists expanded the excavations at the site in 1952–1958. Later work at the cave by Bird and Fell in 1968–1970 led to the publication of the first radiocarbon dates for a late Pleistocene site in South America (Bird 1988), and these ages are still the oldest associated with Fishtail points. Because of its

Michael R. Waters ■ Center for the Study of the First Americans, Departments of Anthropology and Geography, Texas A&M University, 4352 TAMU, College Station, TX 77843-4352 (mwaters@tamu.edu)

Thomas Amorosi ■ Division of Anthropology, American Museum of Natural History, Central Park West at 79th Street, New York, New York 10024-5192, USA; Department of Anthropology, State University of New York, New Paltz, New York 12561 (tamorosi@ix.netcom.com)

Thomas W. Stafford, Jr. ■ Centre for GeoGenetics, Natural History Museum of Denmark, Geological Museum, Oester Voldgade 5-7, DK-1350, Copenhagen, Denmark; Department of Physics and Astronomy, Aarhus University, Ny Munkegade 120, DK-8000, Aarhus C, Denmark (tws@phys.au.dk)

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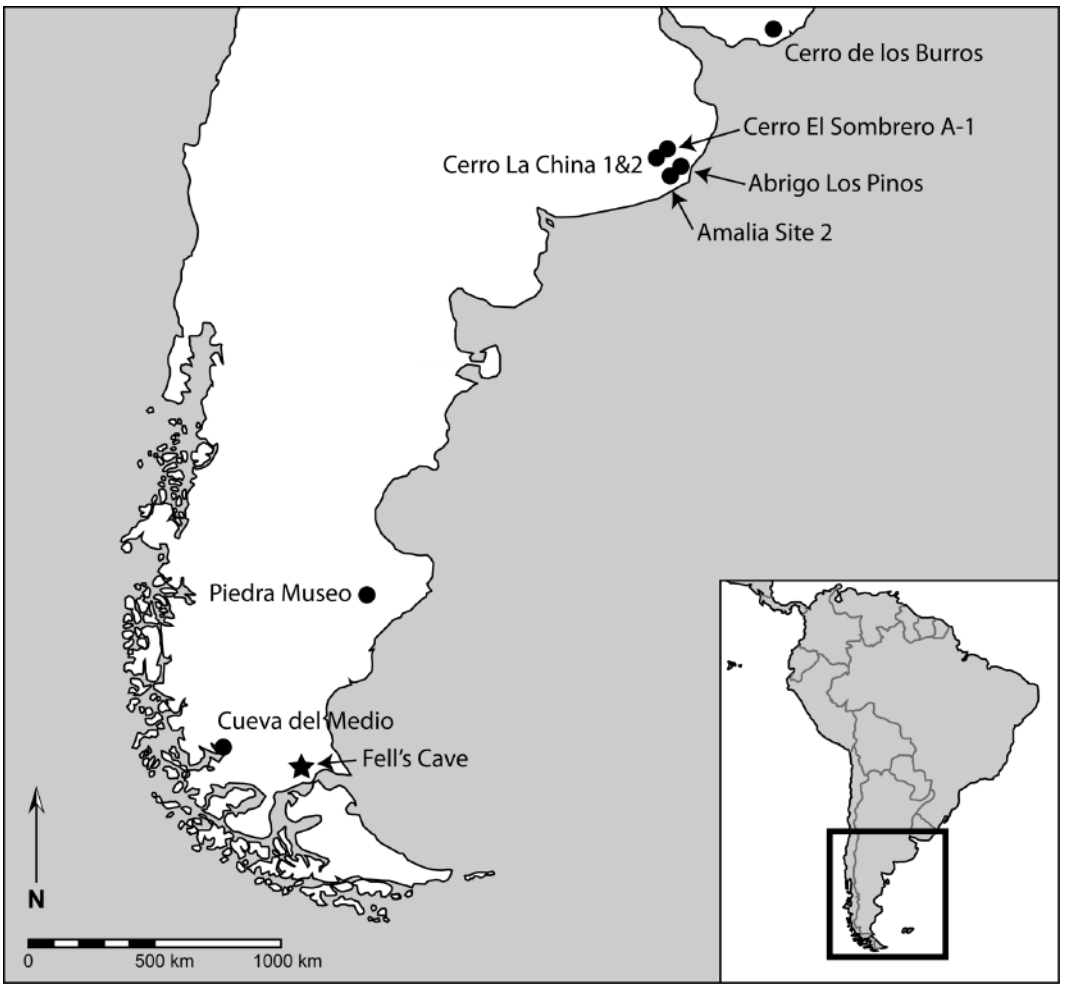

Figure 1. Map showing the location of Fell's Cave and the other dated sites with Fishtail projectile points mentioned in the text.

early age and geographic location at the southernmost tip of South America, Fell's Cave was used as the end point for rapid colonization models of the New World by modern humans. Examination of the radiocarbon record from the cave reveals that there are only three dates from the lower layers containing the Fishtail points (Table 1). These dates have large standard deviations, and radiocarbon technology has advanced significantly since these dates were obtained. During decades of subsequent archaeological work at other sites in the Southern Cone of South America, more Fishtail projectile points have been found in buried contexts, but in all cases, reliable radiocarbon dates from these artifact-bearing layers are younger than the oldest dated occupation layers at Fell's Cave (Jackson 2006; Méndez 2013; Prates et al. 2013). Clearly, the early dates from the Fishtail projectile point horizon within the cave needed to be tested. Fortunately, samples of the charcoal from the same hearths used by Bird to obtain his original dates were found archived at the American Museum of Natural History, New York, and redated using current AMS technology. These new dates redefine the age of the basal Fishtail point layers at Fell's Cave and allow the site to be placed in its proper chronological context relative to new dates from other Fishtail point sites in the Southern Cone.

Table 1. Original and New Radiocarbon Ages from Fell's Cave, Chile.

Geologic Layer	^{14}C yr B.P.	Laboratory Number	Material Dated[a]	Remarks	Reference
Layer 18	10,080 ± 160	I-5146	Charcoal	Hearth; Rejected	Bird 1988
	10,395 ± 30	UCIAMS-104660	ABA-N-Charcoal	Hearth	
	10,395 ± 40	UCIAMS-106044	ABA-Charcoal	Hearth	
Layer 19	10,720 ± 300	W-915	Charcoal	Hearth; Rejected	Bird 1988
	10,675 ± 40	UCIAMS-104662	ABA-Charcoal	Hearth	
	10,760 ± 60	UCIAMS-106043	ABA-Charcoal	Hearth	
Layer 20	11,000 ± 170	I-3988	Charcoal	Hearth; Rejected	Bird 1988
	10,835 ± 50	UCIAMS-106047	ABA-Charcoal	Hearth	
	10,810 ± 50	UCIAMS-106048	Humic Acids	Hearth	

a. Material dated is based on best knowledge of previous techniques. Samples listed as "Charcoal" would have had a standard Acid-Base-Acid pretreatment, which is HCl to remove carbonates, NaOH to remove humates and a final HCl wash to acidify the sample before combustion. Samples processed in this study are denoted either as ABA-Charcoal or ABA-N-Charcoal. ABA-Charcoal was charcoal treated with 1M HCl at 110ºC until solutions were clear and colorless and free of iron; 0.5M KOH at 110ºC to remove alkali-soluble residues (~ humates), and a final washing with 0.06M HCl at RT before freeze drying. Samples listed as ABA-N-Charcoal were extracted with 18M HNO_3 at 110ºC until solutions were clear and colorless. The nitric acid step followed the KOH extraction and was followed by the 0.06M HCl wash before freeze drying. The "Humic acid" fraction is obtained by extracting the charcoal with KOH, centrifuging the solution to remove coarse particles, filtering the solution through 0.45 μm Millex membrane filters, precipitating the ~ humate fraction by adding 6M HCl, centrifuging the product to concentrate the precipitate and washing the precipitated fraction with 0.06M HCl before freeze drying and combustion.

Fell's Cave and Previous Geochronology

Fell's Cave lies north of the Straights of Magellan (Figure 1) along the valley of the Rio Chico (Bird 1988). Late Quaternary sediments in the shelter are approximately 2.5 m thick. Bird (1988) defined five cultural horizons in Fell's Cave, spanning the late Pleistocene to the late Holocene. In the lowest levels of the shelter, he defined the oldest occupation zone, which he termed Period One. In this horizon, 17 Fishtail projectile points (four basally thinned) were identified by Bird, and other lithic and bone artifacts were found, along with hearths filled with wood charcoal. One lanceolate Clovis-like projectile point is reported to be associated with the Fishtail projectile points (Lynch 1978). However, this artifact is not fluted and is a bifacially retouched flake that is thought to be a knife (Nami 1998); the areas that appear to look fluted are actually unaltered portions of the flake blank.

Bird (1988) also recovered from the lower levels the bones of two extinct megaherbivores associated with the Late Pleistocene Lujanian (South American Land Mammal Age [SALMA]) of the Southern Cone. These are the giant ground sloth (*Mylodon darwinii*) and the ancient horse (*Hippidion* sp.). Bird assumed that the presence of these two species was due to human predation.

The purpose of Bird's 1969–1970 excavations was to find material for radiocarbon dating to date the relative cultural sequence in the shelter. Bird (1988) concentrated his efforts on the recovery of wood charcoal from hearths found in each layer. Bird excavated large areas in order to ensure correlation with his previous excavations and because he wanted to find hearths and diagnostic artifacts similar to those he had found decades earlier. During this excavation, Bird defined 23 stratigraphic layers, of which the lower three (Layers 21–23) were culturally sterile.

Period One artifacts from Layers 18–20, including Fishtail projectile points and sloth and horse bones, defined a depositional zone about 25 to 30 cm thick. Bird's 1969–1970 excavation season succeeded in finding many samples to date from the different layers of the shelter (specifically Layers 4, 7, 8, 10–14, and 17–20). Three ages were obtained from hearths in the lowermost layers of the site. These hearths were vertically and horizontally separated from one another (Figure 2). Wood charcoal from hearths in Layers 18, 19, and 20 yielded ages of 10,080 ± 160 radiocarbon years before present (B.P.) (I-5146), 10,720 ± 300

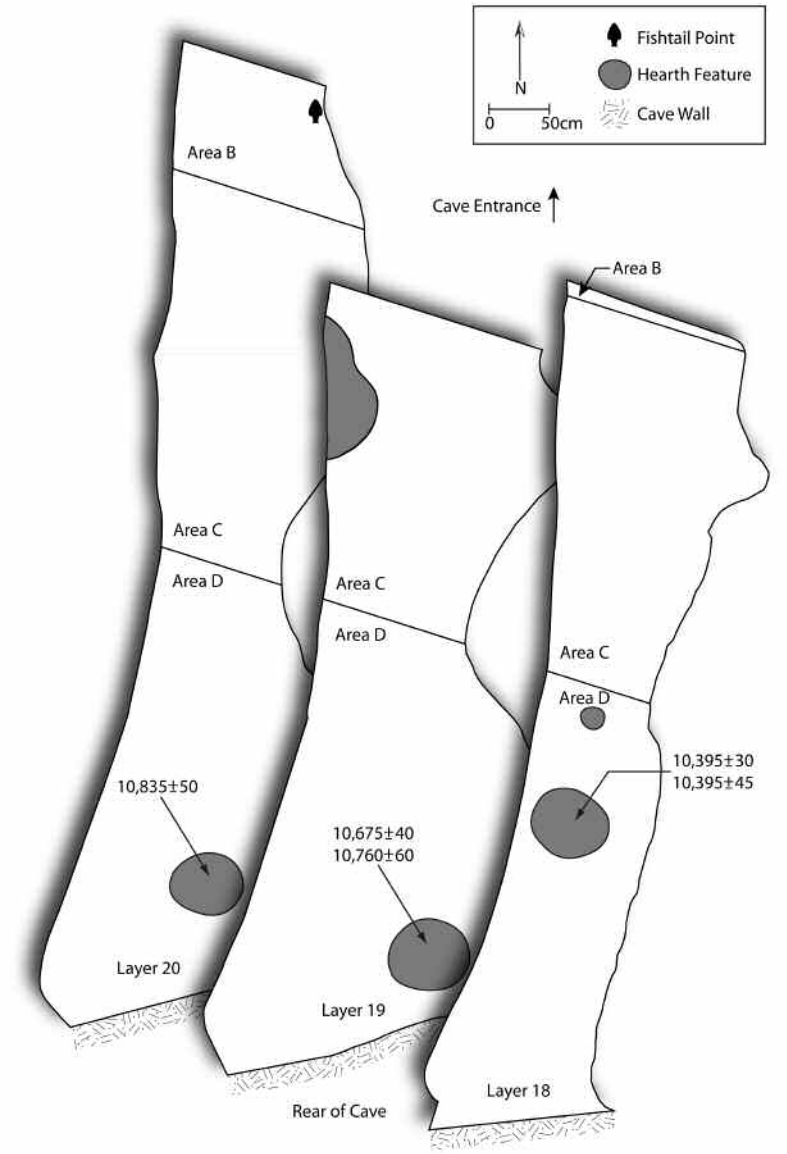

Figure 2. Location of dated hearths in Layers 18, 19, and 20 and Fishtail point in layer 20.

B.P. (W-915), and 11,000 ± 170 B.P. (I-3988), respectively (Bird 1988; Table 1).

New Radiocarbon Dates

Samples of wood charcoal collected for radiocarbon dating by Bird in 1968 and during the 1969–1970 excavation are stored in their original metal and plastic bag containers and are part of the Junius B. Bird Southern Chilean collections curated within the Division of Anthropology at the American Museum of Natural History, New York. These samples were inventoried in 2011–2012 by Amorosi and included samples of wood charcoal used to obtain the original radiocarbon ages from Layers 18, 19, and 20 (Table 1).

The provenance of all charcoal samples that were redated and reported here were properly identified and cross-checked to assure their correct identity. All samples were identified by labels on the containers and within the inner plastic bags. These labels were placed there by Bird and

Table 2. Radiocarbon Ages from South American Sites with Fishtail Projectile Points Recovered From Stratified Contexts.

Site	^{14}C yr B.P.	Laboratory Number	Material Dated	Remarks	Reference
Abrigo Los Pinos, Argentina	10,465 ± 65	AA-24045	Charcoal	Dispersed; same layer as Fishtail Points	Mazzanti 2003; Prates et al. 2013; Valverde 2003
	10,415 ± 70	AA-24046	Charcoal	Dispersed; same layer as Fishtail points	Mazzanti 2003; Prates et al. 2013; Valverde 2003
Cerro La China 1 (CH1), Argentina	10,804 ± 75	AA-8953	Charcoal	Dispersed; same layer as Fishtail points	Flegenheimer 1987; Flegenheimer and Zárate 1997; Mazzia and Flegenheimer 2012; Prates et al. 2013
	10,790 ± 120	AA-1327	Charcoal	Dispersed; same layer as Fishtail points	Flegenheimer 1987; Flegenheimer and Zárate 1997; Mazzia and Flegenheimer 2012; Prates et al. 2013
	10,745 ± 75	AA-8952	Charcoal	Dispersed; same layer as Fishtail points	Flegenheimer 1987; Flegenheimer and Zárate 1997; Mazzia and Flegenheimer 2012; Prates et al. 2013
	10,730 ± 150	I-12741	Charcoal	Dispersed; same layer as Fishtail points	Flegenheimer 1987; Flegenheimer and Zárate 1997; Mazzia and Flegenheimer 2012; Prates et al. 2013
	10,525 ± 75	AA-8954	Charcoal	Dispersed; same layer as Fishtail points	Flegenheimer 1987; Flegenheimer and Zárate 1997; Mazzia and Flegenheimer 2012; Prates et al. 2013
Cerro La China 2 (CH2), Argentina	10,560 ± 75	AA-8956	Charcoal	Dispersed; same layer as Fishtail points	Flegenheimer and Zárate 1997; Mazzia and Flegenheimer 2012; Prates et al. 2013
Cerro El Sombrero, Abrigo (A1), Argentina	10,725 ± 90	AA-4765	Charcoal	Dispersed; same layer as Fishtail points	Flegenheimer 2003; Flegenheimer and Zárate 1997; Mazzia and Flegenheimer 2012; Prates et al. 2013
	10,675 ± 110	AA-4767	Charcoal	Dispersed; same layer as Fishtail points	Flegenheimer 2003; Flegenheimer and Zárate 1997; Mazzia and Flegenheimer 2012; Prates et al. 2013
	10,480 ± 70	AA-5220	Charcoal	Dispersed; same layer as Fishtail points	Flegenheimer 2003; Flegenheimer and Zárate 1997; Mazzia and Flegenheimer 2012; Prates et al. 2013
	10,270 ± 85	AA-4766	Charcoal	Dispersed; same layer as Fishtail points	Flegenheimer 2003; Flegenheimer and Zárate 1997; Mazzia and Flegenheimer 2012; Prates et al. 2013
Amalia Site 2, Argentina	10,425 ± 75	AA-35499	Charcoal	Dispersed; same layer as Fishtail Point	Mazzanti et al. 2012; Prates et al. 2013
Piedra Museo (AEP-1), Argentina	10,470 ± 65	GRA-9837	Charcoal	Dispersed; same layer as Fishtail points	Miotti 2003; Miotti and Salemme 2003, 2005; Prates et al. 2013; Steele and Politis 2009;
	10,400 ± 70	AA-39367	Charcoal	Dispersed; same layer as Fishtail points	Miotti 2003; Miotti and Salemme 2003, 2005; Prates et al. 2013; Steele and Politis 2009
Cueva del Medio, Chile	10,430 ± 80	Beta-52522	Charcoal	Hearth 1; same layer as Fishtail points	Massone 2003; Méndez 2013; Miotti and Salemme 2003
	10,310 ± 70	Gr-N-14913	Charcoal	Hearth 2; same layer as Fishtail points	Massone 2003; Méndez 2013; Miotti and Salemme 2003

his assistants, cross-checked on a hand-written inventory list created by Bird, and confirmed in a typed inventory list again prepared by Bird. The charcoal used to redate Layer 18 came from the same parent sample that was used to obtain the I-5146 date. The charcoal used to redate Layer 19 came from remnants of the original sample processed to produce W-915. The charcoal used to redate Layer 20 came from a remnant sample of charcoal returned to Bird from the Teledyne Isotopes Laboratories in New Jersey in 1968 and which produced the I-3988 date. All samples were processed using standard acid-base-acid pretreatment at Stafford Research Laboratory in Colorado. Samples were dated at the AMS facility at the University of California, Irvine. All calibrated ages are calculated using the IntCal13 database and Calib 7.0.0 (Reimer et al. 2013).

Wood charcoal from the hearth sample from Layer 18 produced two nearly identical results—10,395 ± 30 B.P. (UCIAMS-104660) and 10,395 ± 40 B.P. (UCIAMS-106044). These samples yielded dates that are nearly 300 radiocarbon years older than the original 10,080 ± 160 B.P. (I-5146) age that was measured on a charcoal sample from the same hearth. Bird's original age does not overlap the new ages at one sigma, even with its large standard deviation. The younger age of the original sample may indicate that not all modern soluble organic contaminants were removed during pretreatment. The two new ages average 10,395 ± 25 B.P. and yield a calibrated date between 12,390 and 12,170 calibrated years before present (cal B.P.).

The wood charcoal obtained from the hearth sample from Layer 19 produced two ^{14}C measurements that overlap by one standard deviation. These are 10,675 ± 40 B.P. (UCIAMS-104662) and 10,760 ± 60 B.P. (UCIAMS-106047). These ages average 10,700 ± 35 B.P. and yield a calibrated date between 12,700 and 12,640 cal B.P. This age overlaps the original date of 10,720 ± 300 B.P. (W-915). While Bird's original date and the new ages overlap at one sigma, the original age is rejected because of its large standard deviation in favor of the new ages that have greater precision than the original age.

The wood charcoal obtained from the hearth sample from Layer 20 produced two new dates; one on the acid-base-acid insoluble charcoal residue fraction (10,835 ± 50 B.P. UCIAMS-106047) and one on the alkali-soluble humic acid fraction (10,810 ± 50 B.P. UCIAMS-106048). These statistically identical radiocarbon ages, for the base-soluble and ABA-insoluble fractions, indicate that there is no secondary, geologically older humate contamination of the charcoal samples in the shelter. The charcoal age yields calibrated dates of 12,700 to 12,750 cal B.P. The new radiocarbon ages are younger than the original date of 11,000 ± 170 B.P. (I-3988), but do overlap at one sigma because of the large standard deviation of the original age. Bird's original age is rejected in favor of the new and more precise age.

Fell's Cave in the Context of other Radiocarbon Dated Sites with Fishtail Projectile Points

Fishtail projectile points derive their name from their distinctive fish-like shape with broad shoulders, pronounced and indented stems, and flared bases (Bird 1988; Pearson 2004; Politis 1991). These points are typically made on flake blanks using both percussion and pressure flaking methods with some showing basal thinning. Fishtail projectile points are found at a number of buried and surface sites and are most common in Argentina, Chile, and Uruguay, but are also found in other South American and Central American countries (Jackson 2006; Pearson 2004).

Radiocarbon ages associated with Fishtail points have been obtained from sites in Uruguay, Argentina, and Chile (Flegenheimer et al. 2013; López 2013; Méndez 2013, Nami 2007; Prates et al. 2013; Steele and Politis 2009). In Uruguay, a single Fishtail projectile point was found in a shallowly buried context at the Cerro de los Burros site (López 2013; Nami 2007). Charcoal from the same cultural layer yielded discordant ages of 10,690 ± 60 B.P. (Beta-165076) and 11,690 ± 80 B.P. (Beta-211938) (López 2013; Nami 2007). Until the formation processes at this site are understood and more radiocarbon dates are obtained, this site does not provide useful chronological data to confine the age of the Fishtail projectile point type.

In Argentina and Chile, the situation is different and several sites have yielded multiple and seemingly consistent radiocarbon results on both char-

coal and bone from geologic layers containing Fishtail projectile points (Méndez 2013; Prates et al. 2013). In this report, we use radiocarbon ages only on charcoal from these sites to determine the age of the Fishtail point type. Ages derived on bone are not used because, in most cases, it is not reported which chemical fraction was dated (e.g., apatite, unpurified collagen, purified collagen) and what chemical protocols were used to isolate the chemical fraction. Without this knowledge, it is not possible to assess the quality of the ages derived on bone. In one extreme case, a single cut-marked horse bone from Piedra Museo yielded discordant ages of 10,925 ± 65 B.P. (OxA-8528), 10,675 ± 55 (OxA-15870), and 9952 ± 97 B.P. (AA-39362)(Steele and Politis 2009).

The chronological subsample of charcoal-derived ages consists of 17 radiocarbon ages from seven sites (Figure 1; Table 2). At all sites except one, the charcoal occurs as dispersed pieces within the stratigraphic unit containing the Fishtail projectile points. These ages range from 10,270 ± 85 B.P. (AA-4766) at Cerro El Sombrero, Argentina, to 10,804 ± 75 B.P. (AA-9853) at Cerro La China 1, Argentina. These dates agree well with the new radiocarbon ages from Fell's Cave. Taken together, the chronological range of Fishtail points seems to be from ca. 10,850 to 10,300 B.P. or ca. 12,800 to 12,100 cal B.P. (Figures 3 and 4), as suggested previously (Jackson 2006; Prates et al. 2013). Only two sites in South America, Cueva del Medio, Chile, and Cerro La China II, Argentina, have yielded older ages associated with Fishtail projectile points (Prates et al. 2013). At Cerro La China 2, a date of 11,150 ± 135 B.P. (AA-8955) on dispersed charcoal came from the same geologic layer that produced an age of 10,560 ± 75 B.P. (AA-8956). At Cueva del Medio, a date of 10,930 ± 230 B.P. (Beta-39081) was obtained on dispersed charcoal, but, with the large standard deviation, this date could statistically fall within the range for Fishtail projectile points established by other more precisely dated sites. Finally, at Santa Julia, Chile (Jackson et al. 2007), a basally thinned biface described as a "blank" that expands distally may be a Fishtail point preform. This artifact is directly associated with hearth charcoal dated from 11,090 ± 80 B.P. (Beta-215089) to 10,920 ± 80 B.P. (Beta-194725) and may represent an even earlier age for Fishtail projectile points at ca. 13,000–12,800 cal B.P.

Conclusions

New radiocarbon ages from hearths in Layers 18, 19, and 20 at Fell's Cave show that occupation associated with Fishtail projectile points ranges from 12,750 to 12,200 cal B.P. This range of dates is consistent with radiocarbon ages obtained on charcoal from other Chilean and Argentinian sites that range from ca. 12,800 to 12,100 cal B.P. and are associated with Fishtail points (Jackson 2006; Prates et al. 2013). Fishtail points in the Southern Cone of South American represent a late Pleistocene cultural complex that overlaps with the end of Clovis (ca. 13,000–12,600 cal B.P.; Waters and Stafford 2007, 2013), but is mostly equivalent in time to the Folsom complex (ca. 12,700–12,200 cal B.P.) in the Plains of North America (Jackson 2006).

The remains of extinct giant ground sloth and horse species were found in the lowest levels of Fell's cave in physical association with Fishtail points and other artifacts. However, it is unclear whether the Fishtail projectile points and other artifacts are temporally associated with these extinct fauna. According to Bird's original field notes, Bird thought that the hearths in Layers 18–20 were cut into much older surfaces in Fell's Cave. These bones may already have been in the shelter and exposed at the time of occupation. Only direct dating of the sloth and horse bones from Fell's Cave and a taphonomic study of these remains will conclusively resolve this issue; these studies are ongoing (Amorosi and Prevosti 2008).

The pioneering work of Junius Bird at Fell's Cave created a foundation for future work in South America and broader issues of the peopling of the Americas. The curation of his samples for over 75 years allowed redating of the site and produced a new look at a classic site.

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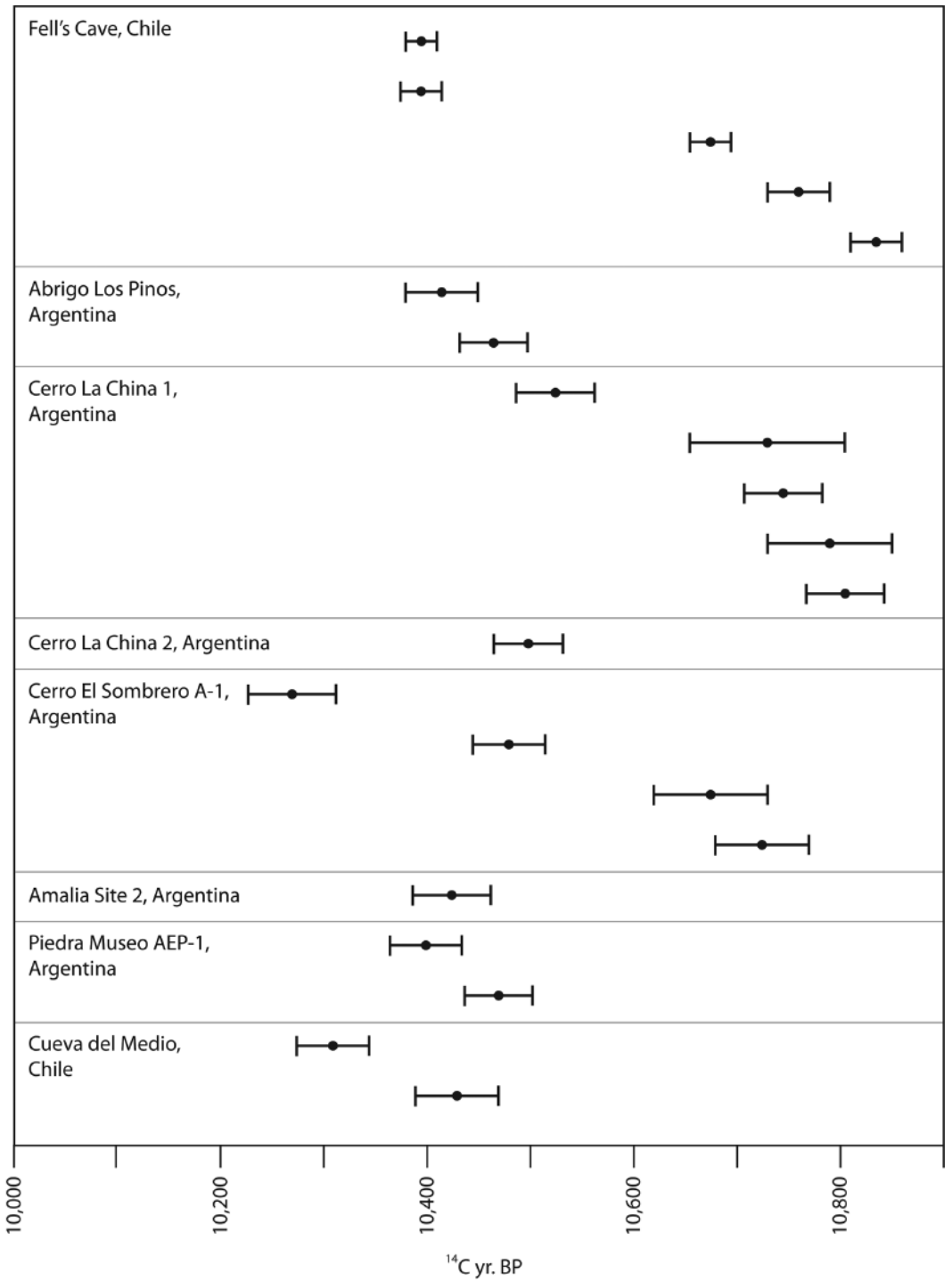

Figure 3. Radiocarbon ages for Fell's Cave and other sites with Fishtail projectile points in the Southern Cone. Solid dots represent the mean of the radiocarbon age and the bars on either side the one sigma range of the age.

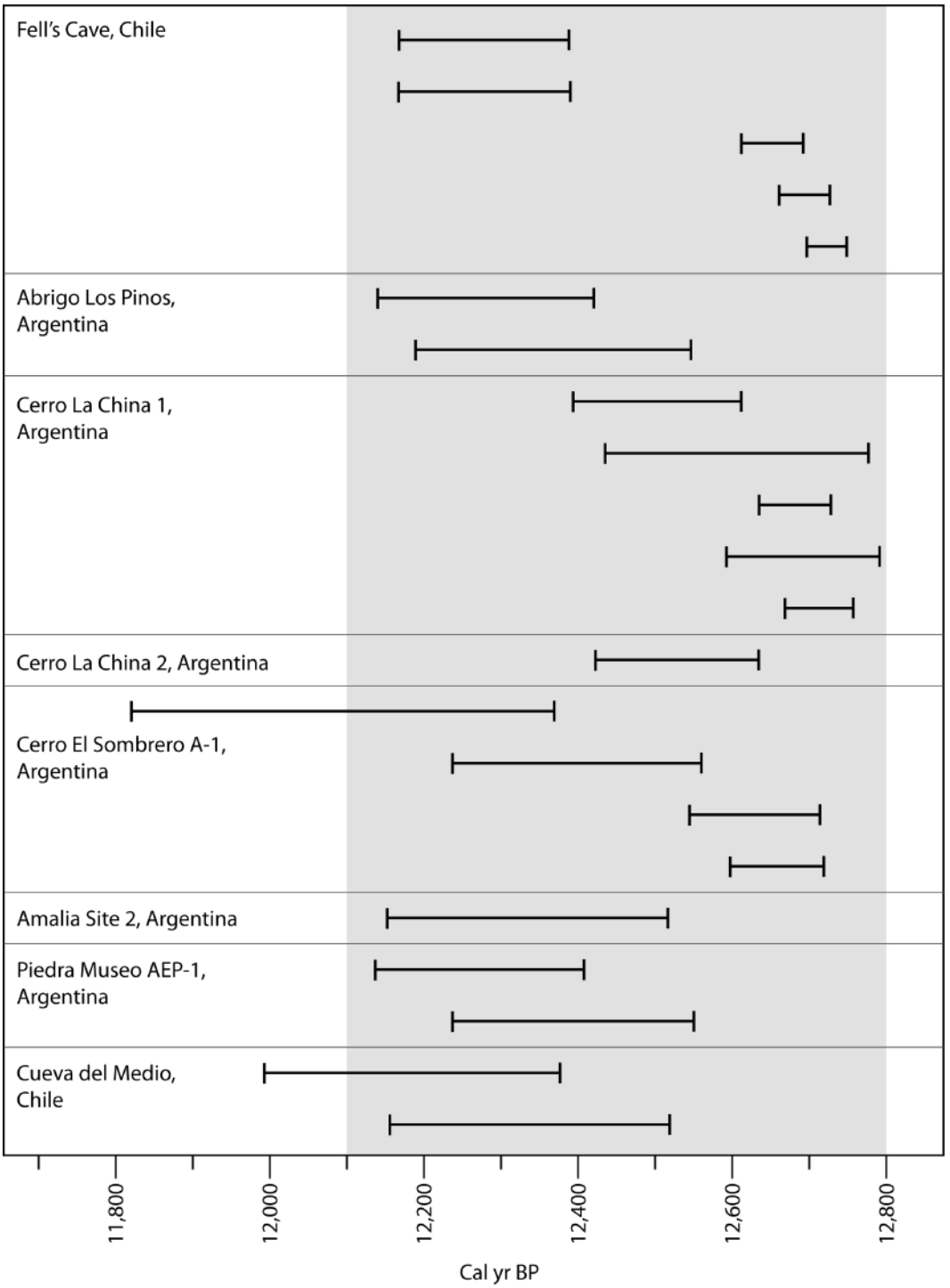

Figure 4. Calibrated dates for Fell's Cave and other sites with Fishtail projectile points in the Southern Cone. Bars represent the calibrated date ranges (at one sigma) for the radiocarbon ages given in Figure 3 and Table 2. Shaded area indicates suggested age range of the Fishtail point type.

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